



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of : Confirmation No. 8243
Takeshi IWAI et al. : Docket No. 2001-1761A
Serial No. 09/993,627 : Group Art Unit 1752
Filed November 27, 2001 : Examiner John S.Y. Chu
POSITIVE-WORKING PHOTORESIST :
COMPOSITION

Rule 132 DECLARATION

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TC 1700

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, the undersigned Satoshi FUJIMURA, do hereby declare:

THAT I am an employee of Tokyo Ohka Kogyo Co., Ltd., Japan, the assignee of the above-identified United States patent application, since April, 1996, being engaged in the research and development works relative to the chemical-amplification positive-working photoresist compositions and other related products of the company;

THAT, I am one of the joint inventors in the above-identified pending United States patent application, I have full acquaintance with the subject matter of the above-identified pending application and have caused the comparative experiments described below either by myself or under my direct supervision; and

THAT I have a good knowledge of the English language and have read and understood the application papers and the prosecution history of the antecedent applications as well as the Examiner's references cited therein.

COMPARATIVE EXPERIMENTS

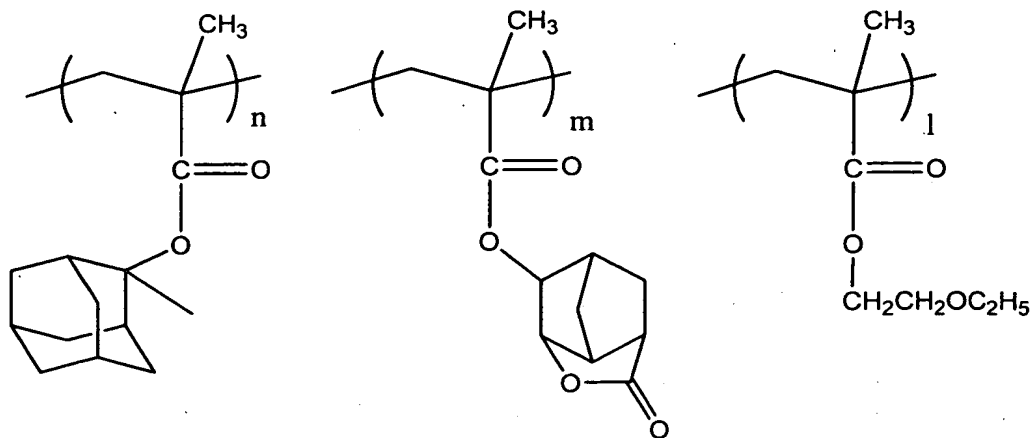
I. Object of experiments

The comparative experiments described below were conducted with an object to demonstrate the unexpectedly distinctive performance of the photoresist composition according to claim 1 of the application in which the monomeric units (a3) of the resinous component (A) was derived from an ester compound between methacrylic acid and a straight-chain alcohol substituted by an alkoxy group or, in particular, 2-ethoxyethyl alcohol according to the limitation of claim 1 as compared with a similar but different comparative photoresist composition in which the monomeric unit of the resinous component corresponding to the (a3) monomeric units in claim 1 was derived from an ester compound between methacrylic acid and a branched-chain alcohol substituted by an alkoxy group or, in particular, 1-ethoxyethyl alcohol.

II. Experimental procedures and results

Experiment 1 (inventive).

A solution of a positive-working resist composition was prepared by dissolving, in 800 parts by mass of propyleneglycol monomethyl ether acetate, 100 parts by mass of a copolymer [component (A)] having a mass-average molecular weight of 9900 and a molecular dispersion of 1.59 and consisting of the monomer units expressed by the formulas



in which n:m:l=52:34:14,

0.2 part by mass of (4-methylphenyl)diphenylsulfonium trifluoromethanesulfonate and 2.0 part by mass of (4-methylphenyl)diphenylsulfonium nonafluorobutanesulfonate [component (B)] and 0.2 part by mass of triethanolamine.

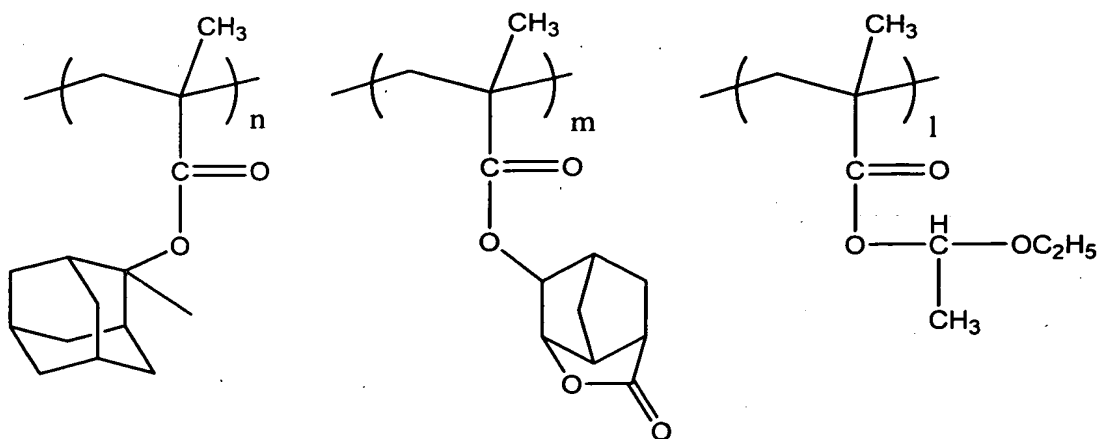
This resist solution was applied by using a spinner onto a silicon wafer provided with an organic antireflection film of 77 nm film thickness (ARC-29A, a product of Brewer Science Co.) and dried on a hot plate at 140 °C (pre-baking) for 90 seconds to form a resist layer of 360 nm film thickness. Next, patternwise irradiation was performed with ArF excimer laser beams (193 nm) on an ArF light-exposure machine (manufactured by Nikon Co., Model NSR-S302A, NA=0.6) followed by a heat treatment (PEB) at 130 °C for 90 seconds and then puddle development for 30 seconds with a 2.38% by mass aqueous solution of tetramethylammonium hydroxide followed by washing with water for 30 seconds and drying.

The resist pattern formed in this procedure had such a critical pattern resolution that a line-and-space pattern of 120 nm could be formed 1:1. The exposure time (sensitivity) there as measured in the unit of mJ/cm² (energy density) was 12.0 mJ/cm². A 130 nm line-and-space pattern had a focusing depth latitude of 0.4 μm. The line edge roughness was 6.5 nm.

The scanning electron microscopic photographs of the patterned resist layers with varied line-and-space widths are attached hereto as Exhibit A.

Experiment 2 (comparative)

A positive-working resist composition was prepared in the same manner as in Example 1 excepting for the replacement of the copolymer as the component (A) in Example 1 with a copolymer having a mass-average molecular weight of 10000 and a molecular dispersion of 1.63 and consisting the monomer units expressed by the formula



in which n:m:l=52:34:14. Next, this resist solution was used to form a resist pattern in the same manner as in Experiment 1.

The resist pattern formed in this procedure had such a critical pattern resolution that a line-and-space pattern of 130 nm could be formed 1:1. The exposure time (sensitivity) there as measured in the unit of mJ/cm² (energy density) was 13.0 mJ/cm². A 130 nm line-and-space pattern had a focusing depth latitude of 0.3 μ m. The line edge roughness was 11.0 nm.

The scanning electron microscopic photographs of the patterned resist layers are shown as the Exhibit B.

Conclusion

As is clearly understood from the above-described results of the comparative experiments, great improvements can be obtained in the line edge roughness, critical pattern resolution and focusing depth latitude in the resist pattern using the inventive photoresist composition of which the resinous component contains units of an ester compound between acrylic or methacrylic acid and a straight-chain alcohol as the (a3) monomeric units.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further

that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of any application or any patent issued thereon.

Date: December 19th, 2003 Satoshi Fujimura
Satoshi FUJIMURA

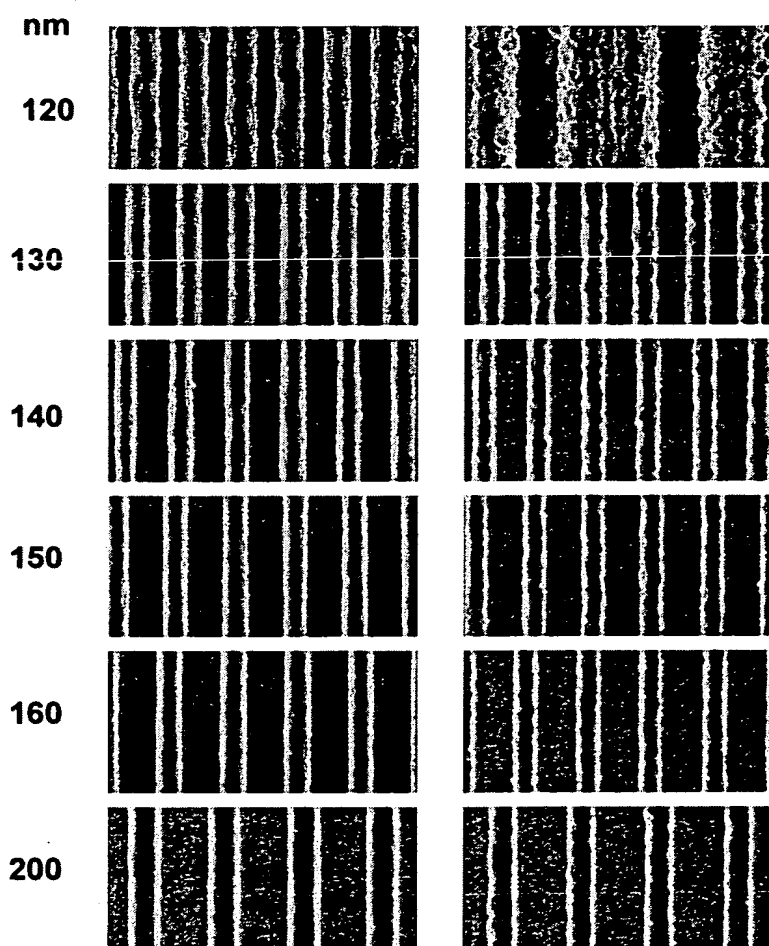


EXHIBIT A

EXHIBIT B